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Indian Standard

RECOMMENDED PRACTICE FOR ELECTROPLATING

(First Revision)

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RECOMMENDED PRACTICE FOR ELECTROPLATING

(First Revision)

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RECOMMENDED PRACTICE FOR ELECTROPLATING

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 15 February 1985, after the draft finalized by the Metallic and Non-metallic Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1966. Keeping in view the experience gained during these years and taking into consideration the rapid developments in the field of electroplating it was felt necessary to revise this standard. In this revision, modifications have been made where necessary, and reference updated. Recommendations for adhesion tests for variety of coatings system have been incorporated in Table 1 and a typical process chart has also been included for the guidance of the electroplaters, in this revision.

0.3 Electroplating, now a days, is an important industrial process which is no longer limited to providing only decorative finish for other metals or non-metals like plastics. Electroplating is now widely used in industry because of its many advantages, like decorative finish, corrosion resistance, corrosion protection, ease of soldering, food preservation, building up of worn out machinery parts, wear resistance etc. In order to produce a good deposit of metal by electroplating, it is necessary to follow a standard procedure. Accordingly, this standard has been formulated to recommend a practice generally followed for obtaining a good metallic coating by electroplating. Details relating to polishing, cleaning, plating equipments, and methods of testing have not been included in this standard, as these are covered under separate Indian Standard, references to which have been made at appropriate places.

0.4 In the preparation of this standard, due consideration has been given to the manufacturing and trade practices followed in the country in this field.

1. SCOPE

1.1 This standard recommends practice for proper electroplating of metallic coatings on metallic surfaces.

2. PREREQUISTES OF THE BASIS METAL

2.1 The basis metal should be free from scales and non-metallic inclusions such as slags and refractories, and also from deep pits blisters, cracks, porosity and burrs. Non-metallic inclusion, being non-conductor, will cause discontinuity in the coating. Scales being hard projection on the surface will present a rough surface after plating.

3. DEGREASING

3.1 The importance of perfect cleaning cannot be over-emphasized, since the adhesion of the deposited metal depends on the efficiency of the cleaning operation of the various processes designed to give a clean surface suitable for electroplating, none is more important than the removal of grease, oil and other soils. Plating on a dirty or greasy surface inevitably leads to blistering or peeling of the deposit.

3.2 Solvent — Cold solvents like kerosene, white spirit, may be used for removal of grease or oil. Though they are of low toxicity, but due to high flammability and low solvent power, they are now replaced by hot chlorinated solvents like trichloroethylene, perchloroethylene, 1,1,1- trichloroethane, etc. These solvents are contained in degreasing units, provided with heating elements at the base and cooling coils round the top edge.

3.3 Aqueous Cleaners — There are wide variety of aqueous type immersion or 'soak' cleaners, neutral detergent types, to highly alkaline type and emulsion cleaners to remove grease and oil. These are generally used hot. There are special hot aqueous cleaning equipments which include ultrasonic vibrations. Electrolytic cleaning, cathodic, or anodic is more rapid in action than immersion cleaning due to the scouring action of the gas evolved on the surface to be cleaned.

4. POLISHING

4.1 After the removal of grease and oil, where necessary, the metal surface should be polished to remove its imperfections, and to give a smooth shiny surface suitable for electroplating. This may be done either by mechanical buffing or polishing, or by chemical treatment electropolishing, etc. For details reference should be made to IS : 3656-1968*.

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*Code of recommended practice for mechanical polishing of metals for electroplating.

5. CLEANING

5.1 After removing the grease or oil or buffing compound on the surface of the metal, the basis metal should be chemically clean, as otherwise the adhesion of the metal deposited will be poor to the substrate, depending on the nature and thickness of the soil — casting skin or corrosion products or sand particles on casting, etc. For details reference should be made to IS : 3194-1965*.

5.1.1 A typical process chart for steel, zinc base alloys, copper alloys, etc, has been given in Appendix A for guidance.

6. PLATING

6.1 Plating Equipment — In electroplating varieties of operations like degreasing, cleaning and finally plating are involved. These operations require tanks or vats for holding the solution, filtration equipments, centrifugal dryers, heaters, dc source of supply like rectifier generators, etc. For bulk processing of components rotating barrels are required. Of late mechanization has been applied to electroplating process on an extended scale and a variety of them — automatic equipments with fixed/multiple programmed transporters, semi-automatic type, apart from mannual type. For the common type of equipment reference should be made to IS : 2679-1974†.

6.1.1 *Anodes* — Soluble and insoluble anodes of suitable composition as specified in the relevant Indian Standards on anodes should be used for electroplating. Sufficient number of anodes of right shape and length, should be used for maximum efficiency. Anode bags of proper material should be used in order to prevent solid particles from soluble anodes getting co-deposited with the metal, causing roughness. Anodes may be in the form of plates, oval castings, balls, square pieces, pellets, etc. For barrel plating, baskets are used to hold the pieces of anodes. Baskets may be of titanium, stainless steel, polypropylene, etc., In the case of ball anodes, wire cages are used in place of baskets.

6.1.1.1 The selection of different types of anodes is dictated by the quality of deposit desired.

6.2 Process for Racked (Jigged) Parts

6.2.1 The treatment cycle for plating should be chosen with care keeping in view the nature of the basis metal and that of the electro-deposit for achieving the properties desired.

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*Recommended practice for cleaning of metal prior to electroplating.

†Recommendations for equipments for electroplating.

6.2.2 Some examples of typical cycles are given below:

a) Hot soak cleaning/electrolytic cleaning (anodic)/rinse/electrolytic acid etch/rinse/rinse/plate/rinse/rinse ;

b) Hot soak cleaning/electrolytic cleaning (anodic)/rinse/acid dip/rinse/electrolytic cleaning (anodic)/rinse/acid dip/rinse/rinse/plate/rinse;

c) Hot soak cleaning/electrolytic cleaning (anodic)/rinse/acid dip/rinse/smut removal/rinse/acid etch electrolytic/rinse/plate/rinse; and

d) Alkali soak cleaning/rinse/aciddi p/rinse/electrocleaning/rinse/sodium cyanide dip/rinse/plate/rinse.

NOTE 1 — Alloy of lead, nickel or silver, nickel/silver plated surfaces should not be anodically cleaned.

NOTE 2 — The design of the rack may be such that a minimum of 150 mm clearance is maintained from the sides and the bottom of the plating tank.

6.3 Process for Parts in Bulk — Components in bulk, suitable for treatment in barrels, should be plated in barrels manually operated or fully automatic (*see* IS : 2679-1964*). Care should be taken in selecting parts to be plated in barrel so that due to their shape and size they do not lock together. The parts get cathodic through studs or dangling contacts, while the anode is held at a distance in the solution and barrel rotated. The chief facility of barrel plating is that racking of small articles required in tank plating is avoided.

6.3.1 A typical treatment cycle for plating is given below:

Tumble cleaning without current in a solution of suitable compounded alkali/rinse/tumble cleaning/rinse/acid dip/rinse/plate/rinse.

NOTE — It is recommended that in cyanide base plating cycle, the acid dip indicated above should be replaced by a cyanide dip.

6.4 Plating Baths — Control and Purification

6.4.1 *Plating Baths* — In general, plating baths are aqueous solutions containing various chemicals and compounds of the metals being plated. These chemicals and compounds may be classified as follows:

a) Simple inorganic salts of high conductivity, for example, chlorides, sulphates, used for plating copper, tin, iron, zinc, palladium, platinum, nickel, etc. Chromic acid is used for chromium plating;

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*Recommendations for equipment for electroplating.

b) Complex inorganic salts, for example, fluoborates, fluosilicates and pyrophosphates, used for plating lead, copper, inidium, tin, etc;

c) Simple organic salts, for example, acetates, used rarely for plating nickel or stereotypes;

d) Complex organic salts, for example, Rochelle salts, sulphamates, and cyanides; and

e) Proprietary brightner additives for bright plates.

6.4.2 *Bath Control* — The working temperature, agitation, filtration, *p*H and other operating conditions of the solution should be carefully controlled according to manufacturers' instructions for better results.

6.4.2.1 All solutions should be subjected to analytical control periodically including determination of the metallic ions, addition agents, and deleterious impurities, etc.

6.4.3 *Bath Purification* — Purification of solutions should be done with a suitable grade of activated carbon conforming to IS : 2752-1978* followed by filtration in a filter press to remove organic and other suspended impurities. The recommended quantity of activated carbon powder shall be 1-3 g/l depending on the degree of contamination. Addition of filter aid conforming to IS : 10472-1983† to the solution removes the particles in suspension and ensures fine and smooth deposit.

6.4.3.1 Chemical purification should be frequently done to remove certain types of impurities from the plating bath. It should not be carried out in plating tank itself, but in a separate purification tank. The most commonly used methods are:

a) zinc dust added to zinc baths to remove nobler metals,

b) high *p*H precipitation of heavy metals from nickel bath carried out at elevated temperature (*p*H is usually raised to 5·5), and

c) for the removal of organic contaminations from the bright plating solution oxidation with potassium permanganate (1-2 g/l) or by H_2O_2 1-2 ml/l (100 vol) for about 30-60 minutes and immediately followed by carbon treatment. It is essential to make a trial conversion on a small volume of solution before any attempt is made to change over the entire plating solution.

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*Activated carbons, granular (*first revision*).

†Specification for filter aid powder for use in electroplating.

6.4.3.2 Electrolytic purification, continuous or intermittent, should be done to remove dissolved metallic contaminations. Current at 0·06 to 1A/dm^2 with corrugated cathodes should be used. Batch dummying may also be used to remove heavy contamination using live large surface area cathodes. Circulation of solution is recommended.

7. HEAT TREATMENT

7.1 Heat treatment for steel base before and after plating (for hydrogen embrittlement) may be adopted as specified in the relevant individual electroplating Indian Standards.

8. POST-PLATING TREATMENT

8.1 Post-plating processes like chromating, phosphating, lacquering, etc, may be adopted as specified in the relevant individual Indian Standards on electroplating.

9. TESTS

9.1 For controlling the quality of deposits, regular testing is necessary. Some important tests are indicated below and should be carried out in accordance with the relevant Indian Standards.

9.2 Thickness Tests — Any of the methods prescribed in IS:3203-1982*, may be used for the determination of local thickness. However, in case of dispute, microscopic (referee) method should be used for this purpose. B.N.F. jet test, coulometric, stripping method, magnetic method, eddy current method, beta back scatter method, etc, may be used in routine checking of thickness.

9.3 Adhesion Test — There is no complete satisfactory test except qualitative tests for poor adhesion. Test methods are useful for production control and for acceptance testing of products. To detect any imperfect adhesion of the deposit to the substrate, one may use any means to separate the coating from the substrate. They may be bending test, burnishing test, chisel-knife test, draw test file test, grind saw test, heat quench test, impact test, peal test, push test, and scribe-grid test. Some are specified in the relevant Indian Standards. Recommended adhesion tests for a variety of coating systems are given in Table 1.

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*Methods of testing local thickness of electroploted coatings (*first revision*).

9.4 Corrosion Tests — Plated components may be subjected to corrosive atmosphere for a specific period to ascertain their corrosion resistance property. Corrosion test may be carried out by the methods as given in IS : 5528-1985*, IS : 6910-1985†, IS : 8038-1985‡ and IS : 9844-1981§. For evaluation of results of these tests guidance may be obtained from IS : 6009-1970||.

10. DESIGN OF ARTICLE

10.1 Besides the fabrication and function of an article, its design plays a vital role in the requirements of finishing processes. Design should preferably avoid deep recesses, concavities that cannot be touched by a ball of 20 mm diameter, sharp edges and blind holes, close over-lapping cavities and tubular stamps where solutions may be trapped. If some of these requirements cannot be fully met in the design of the article, and ability of a bath to deposit metals into deep recessed areas or holes is limited, special technique and careful selection of coating is required where a certain thickness of deposit is essential.

11. CHARACTERISTICS AND USES OF DEPOSITS

11.1 Broad recommendations for characteristics and uses of some metallic coatings are listed in Appendix B.

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*Method of testing corrosion resistance of electroplated and anodized aluminium coatings by copper-accelerated acetic acid salt spray (CASS) test (*first revision*).

†Methods of testing corrosion resistance of electroplated and anodized aluminium coatings by acetic acid salt spray test (*first revision*).

‡Method of testing corrosion resistance of mettalic and other non-organic coatings by corrodkote test (*first revision*).

§Methods of testing corrosion resistance of electroplated and anodized aluminium coatings by neutral salt spray test (*first revision*).

||Method for evaluation of results of accelerated corrosion tests.

TABLE 1 ADHESION TESTS APPROPRIATE FOR VARIOUS COATINGS

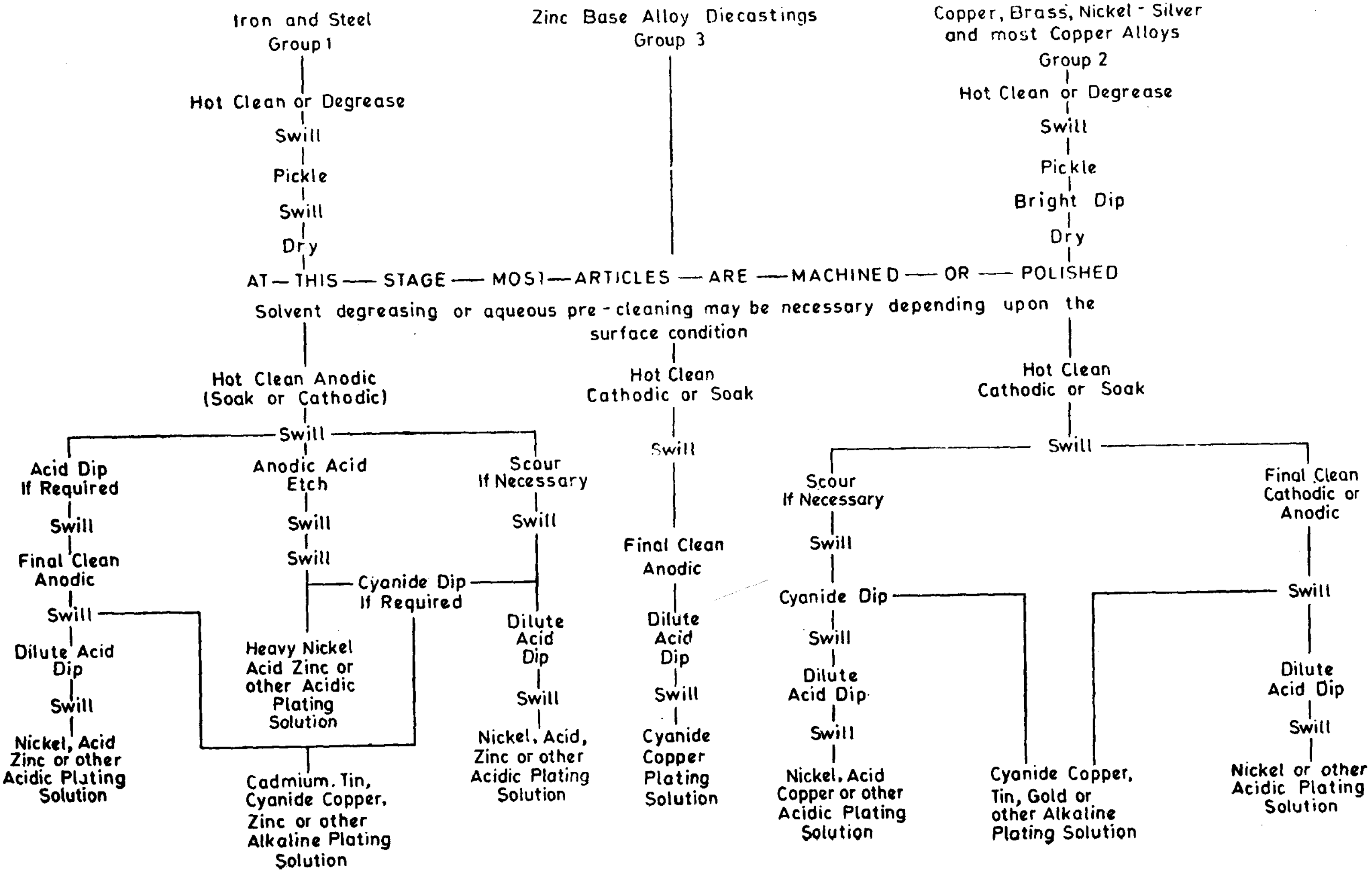
(*Clauses* 0·2 *and* 9·3)

ADHESION TEST	COATING MATERIAL									
	Cadmium	Chromium	Copper	Lead and Lead/Tin Alloy	Nickel	Nickel and Chromum	Silver	Tin and Tin/Lead Alloys	Zinc	Gold
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Bend	—	—	×	—	×	×	—	—	—	—
Burnish	×	—	×	×	×	×	×	×	×	×
Chisel	—	×	×	—	×	—	×	—	—	—
Draw	×	×	×	×	×	×	×	×	×	×
File	—	—	×	—	×	×	—	—	—	—
Grind and saw	—	×	—	—	×	×	—	—	—	—
Heat/quench	—	×	×	×	×	×	×	×	—	×
Impact	—	×	×	—	×	×	—	×	—	—
Peel	×	—	×	×	×	—	×	×	×	×
Push	—	×	—	—	×	×	—	—	—	—
Scribe	×	—	×	—	×	—	×	×	×	×

APPENDIX A

(Clause 5.1.1)

TYPICAL PROCESS CHART


Iron and Steel
Group 1
Hot Clean or Degrease
Swill
Pickle
Swill
Dry
Zinc Base Alloy Diecastings
Group 3
Copper, Brass, Nickel - Silver and most Copper Alloys
Group 2
Hot Clean or Degrease
Swill
Pickle
Bright Dip
Dry
AT THIS STAGE MOST ARTICLES ARE MACHINED OR POLISHED
Solvent degreasing or aqueous pre-cleaning may be necessary depending upon the surface condition
Hot Clean Anodic (Soak or Cathodic)
Swill
Acid Dip If Required
Swill
Final Clean Anodic
Swill
Dilute Acid Dip
Swill
Nickel, Acid Zinc or other Acidic Plating Solution
Anodic Acid Etch
Swill
Swill
Cyanide Dip If Required
Heavy Nickel Acid Zinc or other Acidic Plating Solution
Cadmium, Tin, Cyanide Copper, Zinc or other Alkaline Plating Solution
Scour If Necessary
Swill
Dilute Acid Dip
Swill
Nickel, Acid, Zinc or other Acidic Plating Solution
Hot Clean Cathodic or Soak
Swill
Final Clean Anodic
Dilute Acid Dip
Swill
Cyanide Copper Plating Solution
Hot Clean Cathodic or Soak
Swill
Scour If Necessary
Swill
Cyanide Dip
Swill
Dilute Acid Dip
Swill
Nickel, Acid Copper or other Acidic Plating Solution
Cyanide Copper, Tin, Gold or other Alkaline Plating Solution
Final Clean Cathodic or Anodic
Swill
Dilute Acid Dip
Swill
Nickel or other Acidic Plating Solution

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APPENDIX B

(*Clause* 11.1)

CHARACTERISTICS AND USES OF DEPOSITS

Coating Materials	*Characteristics*	*Some Important Uses*
Cadmium	Protects steel, better solderability than zinc, greater resistance to alkalis, toxic, white and more lustrous than zinc. Relatively expensive, thinner coating will suffice	Protection of ferrous metals, specially against humid conditions and marine atmosphere. As an alkali resistant coating, to reduce bimetallic corrosion and as finish on light equipments
Chromium	Highly tarnish resistant, bright, hard and wear resistant, low frictional properties	Decorative plating, flash chromium to give non-tarnishing properties to an underlying nickel deposit. Heavier deposit for building up worn-out engineering parts, and for reclaiming accidentally overmachined parts. As bearing surfaces, for wearing parts and for other low frictional properties. Also as protective coating to resist chemical attack
Cobalt	Expensive, reflective, hard	Used on printing plates, reflectors and also with some bright nickel
Copper	Ductile and conductive, basic metals to many electrodeposits	As an undercoat for nickel/chromium plating. In electroforming, as protection during selective casehardening. For bronze finish on steel and other metals
Gold	Pleasing colour, non-tarnishing and corrosion resistant even at higher temperatures, good conductor, resists chemical attack	Used on ornamental and decorative works, electrical contacts of low resistance, for example, printed circuits

Coating Materials	*Characteristics*	*Some Important Uses*
Indium	Soft, white, low melting, and corrosion resistant	Used on silver ware and decorative consumer items. For lead-indium alloy plating on heavy duty bearings specifically for aero-engine bearings
Iron	Hard, poor corrosion resistant	Building up worn-out parts, limited application in electroforming
Lead	Resistant to acid fumes and liquids. Soft. Applied in thick deposit	Little commercial use. Used in bearing surfaces
Nickel	Decorative, corrosion resistant, hard, chemical resistant	Widest use in decorative field with a top coat of chromium. Heavier deposit used for building up worn-out parts. Widely used in electroforming. Also a protective coating to resist chemical attack
Platinum	Expensive tarnish and corrosion resistant. Higher reflectivity	Used for ornamental purposes and in radio valves
Rhodium	Expensive, tarnish and corrosion resistant, good conductor. High reflectivity	Surfacing of electrical contact frequently of the sliding or wiping type, for example, sli rings and brushes, selector switches and commutator plati. In jewellery, reflectors of projectors and search lights, some application in electroforming.
Silver	Soft, ductile, lustrous, best conductor of heat and electricity. Fatigue resistant, low elastic modulus, nontoxic	Ornamental; decorative for table-ware; surgical parts, electrical contacts, reflectors, heavy deposition on bearings for heavy loads like aircraft bearings

Coating Materials	*Characteristics*	*Some Important Uses*
Tin	Fairly tarnish and corrosion resistant, easily solderable non-toxic resistant to food stuffs	Manufacture of tinned steel sheets for canning industry and other purposes. Protection to copper and steel cooking utensils, refrigerator trays etc. As a cheap decorative coating in certain application
Zinc	Protects steel, cheaper than cadmium	Protection of ferrous metals especially against industrial and rural atmosphere

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